DOCUMENT RESUME

ED 210 838 EC 140 638

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TITLE Proficiency in Arithmetic Basic Fact Computation of Learning Disabled and Nondisabled Children. Technical Report # 9.
INSTITUTION Columbia Univ., New York, N.Y. Research Inst. for the Study of Learning Disabilities.
SPONS AGENCY Office of Special Education (ED), Washington, D.C.
PUB DATE 80
CONTRACT 300-77-0491
NOTE 18p.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Addition; *Arithmetic; *Computation; Elementary Education; Intermediate Grades; *Learning Disabilities; Multiplication; Subtraction

ABSTRACT

The study involving 183 learning disabled and 852 nondisabled children (grades 3 through 6), investigated students' performance on arithmetic basic fact problems in addition, subtraction, and multiplication. Three separate group administered tests were devised, covering 98 basic addition, 98 subtraction, and 98 multiplication facts. Children were permitted 3 minutes for each test. Performance scores derived were number of problems attempted within 3 minutes, total number of problems correct, and percent correct of number attempted. Learning disabled Ss performed less well than their nondisabled peers on each operation and on all performance measures. Although improved performance was associated with increasing age, the performance of the learning disabled did not equal that of the nondisabled at any age. (Author/SE)

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ED210838

PROFICIENCY IN ARITHMETIC BASIC FACT COMPUTATION OF LEARNING DISABLED AND NONDISABLED CHILDREN

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EC140638

Technical Report #9

1980

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Abstract

This study was undertaken to provide a description of the performance of learning disabled and nondisabled children in grades 3 to 6 on arithmetic basic fact problems in addition, subtraction and multiplication. Subjects were 183 learning disabled and 852 nondisabled children. Three separate group administered tests were devised, covering 98 basic addition facts, 98 subtraction and 98 multiplication facts. Children were permitted 3 minutes for each test. Performance scores derived were number of problems attempted with 3 minutes, total number of problems correct, and percent correct of number attempted. Learning disabled subjects performed less well than their nondisabled peers on each operation and on all performance measures. Although improved performance was associated with increasing age, the performance of the learning disabled did not equal that of the nondisabled at any age. Implications of this performance deficit are discussed.

Proficiency in Arithmetic Basic Fact Computation of Learning Disabled and Nondisabled Children

It is recognized that problems in mathematics achievement are common among learning disabled children. Difficulties in acquiring mathematical concepts and/or arithmetic skills are probably as common and as widespread as difficulties in other academic areas (Cohn, 1971; Otto, McMenemy & Smith, 1973). Despite the apparent prevalence of mathematics learning problems, the data base on which a description of these problems rests is small indeed (Bryan & Bryan, 1978; Hammill & Bartel, 1978; Wallace & McLoughlin, 1979).

A sizable portion of arithmetic instructional time during the elementary school years is devoted to developing computational proficiency in the four operations of addition, subtraction, multiplication, and division. Mastery of basic number facts within whole number operations represents an important computational subskill (Suydam & Dessart, 1976). Basic number facts comprise all single-digit addition and multiplication problems (e.g., $3 + 4$, 5×7). Subtraction and division basic facts are the reverses of addition and multiplication (e.g., $7 - 3$, $7 - 4$, $35 \div 5$, $35 \div 7$). There are 100 basic facts in each of the four whole number operations. Because these facts are a necessary component of more complex arithmetic computations, it has generally been held that speed and accuracy in answering these single-digit problems is important. In fact, a major goal of elementary arithmetic instruction is to bring children to the point where they recall these facts rapidly, where they know basic facts "by heart."

Clinical experience and limited empirical evidence (Myers & Thornton, 1977) have suggested that mastery of basic arithmetic facts represents an area of particular difficulty for learning disabled children. The present study investigated whether learning disabled children and their nondisabled peers differed in speed and accuracy of computation of basic number facts in addition,

subtraction and multiplication, and whether there was a significant interaction between or among diagnostic category, grade level, and arithmetic operation.

Method

Subjects

Subjects (Ss) for this study were 183 learning disabled (LD) children and 842 nondisabled children. Ss ranged in age from 8 to 12 years, and in grade placement, from 3rd to 6th grade.

The LD Ss were in self-contained classrooms in 3 private day schools for LD children in New York and New Jersey. Mean IQ for the group was 96.6; SD = 14.3. The Ss were classified as LD under the regulations of New York and New Jersey, which stipulate that such classification follow complete psychoeducational and medical examination.

The nonhandicapped Ss were enrolled in 5 schools in 2 school districts. One district (3 schools, 362 Ss) is in South-central Maine, in a relatively rural area. Although the second district, in the mid-Hudson region of New York (475 Ss) covers a large and diverse geographic area, Ss were drawn from two schools situated 3 miles apart in a rural-suburban area. No IQ measure was available for the nonhandicapped students. However, children who were classified as handicapped were identified by code number by school authorities, and their test performance was not included in the analysis.

Materials

The materials used in this study were designed to measure proficiency in basic fact problems in addition, subtraction and multiplication. Three separate tests were devised: covering 98 different basic addition problems, 98 basic subtraction problems, and 98 basic multiplication problems, respectively. The problems of each test were randomly sequenced.

Each of the tests consisted of two pages with 49 problems on each page. Numerals were printed in bold "primary" type; all problems were presented in

a vertical format, arranged in seven rows, each containing seven items. Ample space was provided for writing a response under each example.

Procedures

All Ss were administered the addition and subtraction fact test. Only the older Ss (Grades 5 and 6) were given the multiplication test. Counterbalancing procedures were used to vary the order of presentation of the tests.

Each test was group-administered by the classroom teachers, who timed the tests, allowing three minutes for each. At the conclusion of each three-minute interval, tests were collected before the next test was distributed. Thus, a sample of performance in addition, subtraction, and multiplication was gathered for LD and nonhandicapped children.

Results

Three scores were derived for each basic fact test: number attempted (of 98 problems available), number correct (of problems attempted), and a "proficiency index" (percent correct of number attempted). Data presented in Table 1 relate to these three dependent measures, and are reported separately for each grade level.

Number Attempted

The measure "number attempted" serves as an index of computation speed. In order to compare the performance of LD Ss, a 2 x 2 (group x grade) analysis of variance was carred out on the scores reported in Table 1.

Table 1

Means and Standard Deviations of Number Attempted (of 98 examples) in Addition, Subtraction and Multiplication Basic Fact Problems by LD and Nondisabled Children

Group	Addition Attempted	Subtraction Attempted	Multiplication Attempted
Grade 3			
LD (N = 54)	29.8 (18.9)	22.8 (15.1)	
Normal (N = 202)	58.3 (19.3)	47.8 (18.3)	
Grade 4			
LD (N = 35)	37.0 (24.6)	28.5 (21.7)	
Normal (N = 177)	71.6 (17.5)	54.2 (21.1)	
Grade 5			
LD (N = 29)	47.3 (21.8)	35.1 (17.4)	32.4 (12.8)
Normal (N = 232)	79.3 (16.6)	64.1 (19.7)	75.5 (20.9)
Grade 6			
LD (N = 65)	60.7 (22.7)	47.1 (22.4)	47.0 (26.1)
Normal (N = 231)	86.3 (15.9)	74.9 (21.3)	82.8 (19.1)

Results of the 2 x 2 analysis of variance reveal a significant main effect for group for each operation (addition, F (7,1015) = 364.18, $p < .001$; subtraction, F (7,1015) = 248.18, $p < .001$; multiplication, F (3,540) = 224.89, $p < .001$) as well as a significant main effect for grade for each operation (addition, F (7,1015) = 119.70, $p < .001$; subtraction, F (7,1015) = 85.20, $p < .001$; multiplication, F (3,540) = 20.45, $p = .001$). No interaction effect of group x grade was found. Data in Table 1 show that LD Ss attempted fewer basic fact problems in each three-minute period than did their nondisabled peers, and that the number attempted increased with age in both groups.

Number Correct

While "number attempted" in each three-minute timed trial is an index of computation speed, "number correct" is a measure of accuracy. Table 2 provides performance data for LD and nondisabled Ss on the number of problems correctly answered of the 98 examples available.

Table 2

Means and Standard Deviations for Number Correct (of 98 examples) in Addition, Subtraction and Multiplication Basic Fact Problems by LD and Nondisabled Children

Group	Addition Correct	Subtraction Correct	Multiplication Correct
Grade 3			
LD (N = 54)	26.6 (20.7)	18.0 (15.6)	
Normal (N = 202)	57.0 (19.3)	56.2 (18.7)	
Grade 4			
LD (N = 35)	35.6 (24.9)	25.4 (22.4)	
Normal (N = 177)	70.2 (17.6)	52.2 (22.2)	
Grade 5			
LD (N = 29)	46.0 (22.6)	33.1 (17.6)	26.1 (14.0)
Normal (N = 232)	77.1 (17.7)	62.4 (20.3)	73.5 (22.3)
Grade 6			
LD (N = 65)	59.0 (22.8)	44.7 (23.1)	42.3 (27.8)
Normal (N = 231)	85.1 (16.1)	73.5 (21.9)	81.2 (19.8)

A 2 x 2 (group x grade) analysis of variance was carried out on data relating to each operation, and significant main effects for group (addition, F (7,1015) = 368.92, $p < .001$; subtraction, F ((7,1015) = 264.51, $p < .001$; multiplication, F (3,540) = 250.31, $p < .001$) and for grade were found (addition, F (7,1015) = 116.71, $p < .001$; subtraction, F (7,1015) = 87.40, p .001; multiplication, F (3,540) = 19.73, p = .001). No interaction between group and grade was found. Thus, nondisabled Ss performed better on this measure than did LD Ss, and both groups' performance scores improved with age.

Proficiency Index

This measure was derived in order to investigate whether LD Ss were slower, but not less accurate, in computing basic fact problems. The two previous measures of performance were based on total number (98) of problems available to be solved in each three-minute trial. The proficiency score is the percent correct of number attempted, and thus reflects accuracy of computation regardless of speed.

Table 3 reports mean, median and modal class proficiency scores for LD and nondisabled Ss, by grade, and for total group. The distribution of scores was markedly skewed in both groups. Although more variability in performance of the LD Ss is reflected by their lower mean scores and higher standard deviations at each grade, the inference can be drawn that both groups had a high percentage of correct responses to problems attempted.

Table 3.

Means, Standard Deviations, Mode and Median of Proficiency Scores (Number Correct/Number Attempted) in Addition, Subtraction and Multiplication Basic Fact Problems for LD and Nondisabled

Group	Addition			Subtraction			Multiplication		
	Mean	Median	Mode	Mean	Median	Mode	Mean	Median	Mode
Grade 3									
LD (N=53)	0.80 (0.30)	.96	1.00	0.72 (0.33)	.81	1.00			
Normal (N=202)	0.97 (0.07)	.99	1.00	0.95 (0.10)	.98	1.00			
Grade 4									
LD (N=34)	0.94 (0.09)	.98	1.00	0.84 (0.21)	.94	1.00			
Normal (N=177)	0.98 (0.04)	.99	1.00	0.95 (0.09)	.98	1.00			
Grade 5									
LD (N=29)	0.94 (0.19)	.99	1.00	0.93 (0.19)	.98	1.00	0.84 (0.21)	.73	1.00
Normal (N=232)	0.97 (0.09)	.99	1.00	0.96 (0.07)	.99	1.00	0.97 (0.06)	.99	1.00
Grade 6									
LD (N=65)	0.97 (0.05)	1.00	1.00	0.93 (0.11)	.97	1.00	0.85 (0.22)	.93	1.00
Normal (N=231)	0.99 (0.02)	.99	1.00	0.97 (0.05)	.99	1.00	0.98 (0.05)	.99	1.00
Total									
LD (N=183)	0.91 (0.20)	.98	1.00	0.85 (0.24)	.95	1.00	0.85 (0.25)	.88	1.00
Normal (N=842)	0.98 (0.05)	.99	1.00	0.96 (0.07)	.98	1.00	0.98 (0.04)	.99	1.00

Discussion

This study was undertaken in order to provide a description of the relative performance of LD and nonhandicapped children in grades 3 to 6 on basic fact problems in addition, subtraction and multiplication. Mastery of basic facts has been considered to be a necessary, but not sufficient, condition for overall arithmetic achievement (Suydam & Dessart, 1976). It has been held that the degree of automaticity of recall of basic facts may influence performance on more complex arithmetic computations, since easy access to basic facts may allow attention to be more easily deployed to other aspects of arithmetic tasks (Garnett, 1979).

It is clear that the LD children in this study were not so proficient in basic fact computation as were their nondisabled peers. The measure of computation speed (number attempted in each three-minute trial) provides the most striking difference: the nondisabled children in Grade 3 performed, on the average, as well as the LD children in Grade 6. Several factors may contribute to this lack of proficiency. It may be that slow psychomotor speed influences the rate of writing of LD children, and thus negatively affects their arithmetic performance on time trials.

Another possibility is that LD children may use reconstructive processes more often when doing basic fact computation, whereas their nondisabled peers may more frequently rely on reproductive processes. This distinction was discussed by Groen and Parkman (1972), Groen and Resnick (1977), and Svenson (1976).

In an effort to explain the markedly different performance of LD and nondisabled children in this study, their test protocols were examined. No

indication was found that nondisabled children used overt counting to arrive at the solution to problems, whereas a substantial number of LD children had worked out the problems by making lines, or marks, and apparently, counting them. Overreliance on reconstructive procedures could have a clear negative effect on speed.

Finally, it may be that LD children, as a group, show less tendency to automatize the routine aspects of task performance. A significant relationship between automatization and basic fact proficiency has been demonstrated by Garnett (1979).

In addition to being slower in computing basic fact problems, LD children as a group make more errors of computation than do their nonhandicapped peers. Note must be taken of the greater variablility of performance in the LD group. However, certain trends seem apparent in the proficiency indices of LD and nondisabled groups.

The youngest LD children (Grade 3) did notably less well than any other age group of LD children. This may reflect the uncertainty of process or operation associated with the early stages of arithmetic instruction. Thus, these children may simply have been delayed in arriving at the stage where computational accuracy might be expected of them. This might reflect a prolonged period of arithmetic readiness instruction in the first years of schooling, or might reflect the children's inability to grasp number concepts at the ages when nondisabled children did. These explanations are speculative; studies should be carried out with younger LD children in order to ascertain how they may differ. from their nondisabled peers in the development

of computational skills.

A general developmental progression in "proficiency" is seen in both groups. Thus, as the children got older, the trend was for greater accuracy of response to those problems attempted.

Basic fact mastery is only one part of the arithmetic curriculum of the elementary school. However, lack of computational skill has been cited in taxonomies of developmental arithmetic disability by Cohn (1968), Johnson and Myklebust (1964), and Kosc (1974). Mastery of basic facts within whole number operations represents a computation subskill in which LD children do not demonstrate the same level of mastery as do their nondisabled peers.

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